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Short communication

# A study on comparative longevity of banked and freshly collected seeds of two wild sesame species

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**Abstract**

Seed longevity was studied in the two species of wild sesame by ageing them at 50 °C and 60% RH in an oven. This was meant to generate information to guide collection, evaluation and management of seed accessions for *ex-situ* conservation of the wild species. Sampling was done at predetermined intervals and germination carried out on 1% water agar at 35/15 °C alternating temperature and 12/12 h photoperiod. Germination was scored as emergence of radicle and seed survival data subjected to probit analysis to derive seed longevity parameters and survival curves. Results indicated that *Sesamum angustifolium* and *Sesamum angolense* are long-lived species with no inter-specific differences. However, freshly harvested seeds were shown to be short-lived relative to the pre-banked samples and probable reasons are attributed.
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*Keywords:* Accelerated ageing; Conservation; *Ex-situ*; Genetic erosion; *In-situ*; Seed longevity; Wild sesame species

## 1. Introduction

Seed longevity studies contribute important information on the *ex-situ* conservation of orthodox-seeded species. Seed banks rely on good understanding of seed storage potential for proper management of accessions meant for long-term conservation. With the current unprecedented loss of wild species and increased genetic erosion *in-situ*, *ex-situ* plant conservation strategies remain the most promising measure of ensuring continued survival of the genetic material for utilization in crop/plant improvement or in re-introduction of species for rehabilitation of degraded habitats. Wild sesame genetic resources are of immense actual and potential economic value to agriculture as they possess attributes that could be used to improve the cultivated *Sesamum indicum* L. Furthermore, most of the habitats where these species and many others grow are becoming degraded due to both human activities and climatic changes (Wass, 1995). The need for their *ex-situ* conservation therefore cannot be overemphasized.

Seeds for long-term conservation are required to maintain viability for long periods in storage if the inherent regeneration costs are to be minimized (Roberts, 1991) and generate seedlings that can survive environmental stresses (Probert and Hay, 2000). Seed longevity is thus the period over which a seed is able to germinate under favourable conditions (Roberts and Ellis, 1982). A good understanding of the potential seed longevity of a given species is imperative for guiding the viability monitoring decisions.

Potential longevity of seeds depends on seed quality at the time of entering storage (Probert and Hay, 2000). In addition, seed moisture content and storage temperature conditions will influence seed longevity (Harrington, 1970, 1972; Roberts, 1973; Ellis and Roberts, 1980a,b; Dickie et al., 1990; Smith, 1992; Steiner and Ruckenbauer, 1995).

Drying seeds to low (≤5%) moisture content and storing them at sub-zero temperatures is a common practice in

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Table 1
Seed longevity parameters fitted by probit analysis for *Sesamum angolense* (SA) and *Sesamum angustifolium* (SC)

| Seed lot | $P_{50}$ (days) | se | Slope (1/σ) | se | $K_i$ | σ (days) |
|---|---|---|---|---|---|---|
| SA freshly harvested | 38.14 | 0.73 | −0.088 | 0.006 | 3.36 | 11.37 |
| SA — banked | 92.51 | 2.01 | −0.023 | 0.002 | 2.12 | 43.63 |
| SC freshly harvested | 42.57 | 0.87 | −0.062 | 0.004 | 2.65 | 16.08 |
| SC — banked | 89.71 | 1.65 | −0.026 | 0.002 | 2.32 | 38.71 |

Time taken for seed viability to fall by 50% ($P_{50}$), seed lot constant ($K_i$), the standard deviation of the frequency distribution of seed deaths in time ($\sigma$) and the reciprocal of the $\sigma$ (slope).

germplasm conservation of many orthodox-seeded species. Such seeds can maintain high viability (Ellis and Pieta Filho, 1992; Probert and Hay, 2000) and seed survival curves can be used to describe the pattern of loss of viability and predict longevity in storage (Ellis and Roberts, 1980a).

Seeds of wild *Sesamum* species: *Sesamum angolense*, *Sesamum angustifolium* and *S. latifolium*, were collected and banked at the National Gene Bank of Kenya under the auspices of the Seeds for Life Project, a partnership among five national institutions in collaboration with Royal Botanic Gardens Kew. However, the collections have not been evaluated for their potential longevity. As has been stated, knowledge of their potential longevity in storage is essential in guiding curation decisions on viability monitoring and germplasm regeneration. This study was thus initiated to determine potential seed longevity for two of these species, and was also aimed at assessing the seed longevity differences between *S. angolense* and *S. angustifolium*. The study was also aimed at assessing the seed longevity differences between the two species and between their pre-banked and freshly harvested seeds.

## 2. Materials and methods

Seed samples for this study were collected from wild populations of *S. angolense* and *S. angustifolium* at the point of natural dispersal. Seed accessions that had been harvested, dried to equilibrium moisture content at 20 °C and 18–20% relative humidity (RH), hermetically sealed and stored for two years at +5 °C at the National Gene Bank of Kenya were used to assess effects of storage on seed longevity. The other seed material comprised freshly harvested seeds that were dried to equilibrium moisture content under similar conditions. The accelerated ageing test was carried out in an oven at 50 °C. Each sample was subdivided into 33 replicate samples of 100 seeds each, enough for 28 germination and 5 moisture content (MC) sampling points and placed in 20 ml open glass bottles. They were then hydrated over a 60% RH lithium chloride (600 g/L in distilled water) in an electro-speed box (28.5 cm l × 28.5 cm w × 3.5 cm h). (An electro-speed box is a simple rectangular or square box made of tough plastic and which can be closed by screwing to facilitate air-tight conditions.) A plastic netting held by 50 mm high plastic support was placed in the box and the bottles containing the seed samples laid on top of the netting in a horizontal position to ensure that the seeds spread in a thin layer. The electro-speed box was tightly closed and placed at +5 °C for 21 days for samples to re-hydrate to equilibrium moisture content and reduce the seed-to-seed moisture content variation by bringing samples to the same level of moisture content. After the equilibration was achieved, the boxes containing the seed samples were then transferred into an oven maintained at 50 °C for accelerated ageing. Sampling was done at days 0, 1, 2, 3, 5, 8, 12, 15, 20, 25, 30 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 105, 112, 119 and 126 for viability assessment, using germination testing at 30/15 °C temperature. Probit analysis on seed survival data were analyzed using GenStat® Release 4.23DE to provide estimates of $P_{50}$ (time taken for viability to decrease by 50%), $K_i$ (seed lot constant which is a measure of seed viability (% probit) before storage and $\sigma$ (standard deviation of the frequency distribution of seeds deaths in time). In addition, seed survival data of aged seeds were regressed against the corresponding days in storage to give survival curves using Microcal Origin®. Using the slope of the curves ($1/\sigma$) as the seed deterioration rate, longevity of seed was compared for the species.

## 3. Results

Both pre-banked and fresh seed lots of *Sesamum*: *S. angolense* and *S. angustifolium* seeds showed high initial germination, all scoring 99% germination and above (Table 1). In addition, the seeds maintained viability at the ageing temperatures for relatively protracted periods. However, as expected, during accelerated ageing, seed vigour for the two species progressively diminished for all the seeds lots.

During accelerated ageing, $K_i$ values of the freshly harvested seeds were consistently higher than those of the pre-banked seed lots, but freshly harvested seed lots were observed to die faster compared with the respective samples for pre-banked

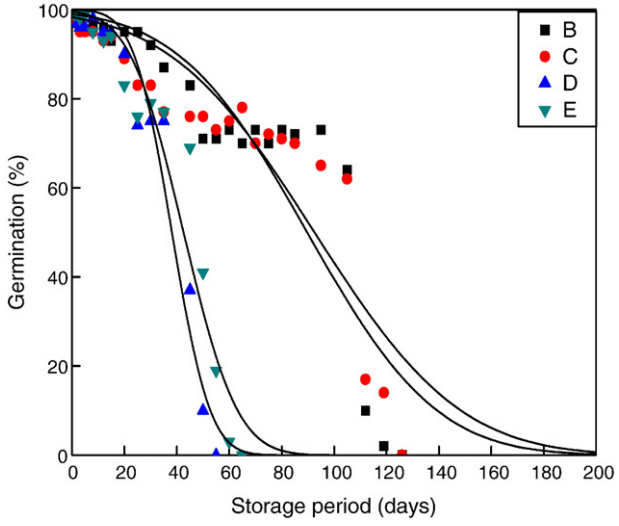


Fig. 1. Survival curves fitted by probit analysis (best fit regressions) constrained to individual slopes and $K_i$ values for *Sesamum* species seed. Key: B-banked *S. angustifolium*; C-banked *S. angolense*; D-freshly harvested *S. angustifolium*; E-freshly harvested *S. angolense*.

seeds (Table 1 and Fig. 1, respectively). For instance, the $P_{50}$ values for the freshly harvested seeds were 38.14 and 42.57 days while those for pre-banked seeds were 92.14 and 89.71 days for *S. angolense* and *S. angustifolium* (Table 1 and Fig. 1) respectively.

There was no significant increase in the residual deviance by constraining the survival curves of the two species to a common slope ($P=0.05$). Similarly, there was no significant increase in the residual deviance by constraining the survival curves of the two species to a common line either ($P=0.05$). However, there was significant increase in the residual deviance by constraining the survival curves of the banked and freshly harvested seed for the respective species either to a common slope or a common intercept.

## 4. Discussion

The fact that the survival curves for *S. angolense* and *S. angustifolium* could not be constrained to either a common intercept or a common slope without a significant increase in deviance implies that either the common slope model or the common intercept model for the seed lots of the species is acceptable. The observed differences in longevity can therefore be attributed either to differences in initial seed quality ($K_i$) or differences in rate of loss of viability ($\sigma$). However, considering that the respective high $K_i$ values did not necessarily result in higher $P_{50}$ values for the corresponding seed lots, implies that the observed differences in longevity between the pre-banked and freshly harvested seed lots can largely be attributed to differences in rate of loss of viability ($\sigma$). This is not surprising considering that *S. angolense* and *S. angustifolium* are two distinct species growing in different varied habitats which might therefore be expected to have different sigma ($\sigma$) values (Ellis and Roberts, 1980a,b). Longevity differences have also been reported to be apparent between seed lots of the same species in other cases (Walters et al., 2005).

Freshly harvested seeds showed higher $K_i$ values compared with pre-banked seeds, the viability of which is expected to have declined in storage. However, pre-banked seeds had higher values of $\sigma$ compared to freshly harvested seeds (Fig. 1 and Table 1). Higher $\sigma$ values for pre-banked seeds imply that, in spite of their lower $K_i$, the pre-banked seeds are more resilient under accelerated ageing conditions, than freshly harvested seeds. These differences may be the outcome of one or more factors resulting in faster deterioration of freshly colleted seeds compared with pre-banked seeds. Firstly, some unknown post-harvest physiological changes including expected reductions in seed MC during after-ripening processes in storage may have been implicated in improved seed quality for banked seeds. This was envisaged due to the fact that seed dormancy was seen to have declined and germination rate increase for the seeds when banked for some time compared with seeds at harvest (Obunyali, 2007). Seed moisture content and temperature are two factors that greatly influence seed longevity (Harrington, 1972; Ellis and Roberts, 1980b; Ellis et al., 1986, 1988). In addition, some physiological changes known to occur during post-harvest storage may have enhanced the ability for seed germination for pre-banked seed (Bewley and Black, 1994). However, harvesting seeds at post-abscission stage is normally crucial for capturing optimal seed quality that will ensure maximum seed longevity (Hay and Probert, 1995).

Another possible explanation for the apparent differences in longevity between freshly harvested and pre-banked seed may be due to the effects of environmental conditions during seed development. Fresh seeds may have developed in sub-optimal conditions compared to the pre-banked seeds. Prevailing climatic conditions during seed development are known to influence seed quality that can result into seed longevity differences between seed lots of the same species (Probert and Hay, 2000; Walters et al., 2005). Unfortunately, however, such climatic data are not available for the *Sesamum* spp. seeds presently investigated.

## 5. Conclusion and recommendations

This study has revealed that while *S. angustifolium* and *S. angolense* are both long-lived with no differences in longevity between the two species, potential seed longevity can be influenced by external factors. Therefore, seed viability monitoring regimes should be so designed as to ensure that the detection of loss of viability is timely. Detailed longevity studies on effects of external factors and precise patterns of viability loss will enhance accurate designing of their viability monitoring regimes.

However, data on provenance of the species and environmental conditions that prevailed during seed development of the seed samples used in this study were not recorded. It is therefore recommended that further studies be carried out on environmental effects on seed quality and longevity for the species. Harvesting data to show relative seed maturity in relation to longevity should also be recorded. Such parameters could offer some insight in understanding seed quality aspects for wild *Sesamum* spp. for conservation in gene banks. The differences in longevity between freshly harvested and the pre-banked seed lots re-emphasize the need to bank high-quality seeds. It is thus imperative to ensure that when acquiring seeds meant for long-term conservation, measures to ensure h extended longevity are effected.

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## References

Bewley, J.D., Black, M., 1994. Seeds; Physiology of Development and Germination, 2nd ed. Plenum Press, New York.

Dickie, J.B., Ellis, R.H., Kraak, H.L., Ryder, K., Tompsett, P.B., 1990. Temperature and seed storage longevity. Annals of Botany 65, 197–204.

Ellis, R.H., Pieta Filho, C., 1992. Seed Science Research 2, 9–15 (potential longevity of seeds in storage, in relation to maturity).

Ellis, R.H., Roberts, E.H., 1980a. Improved equations for the predication of longevity. Annals of Botany 45, 13–30.

Ellis, R.H., Roberts, E.H., 1980b. The influence of temperature and moisture on seed viability period in barley (*Hordeum distichum* L.). Annals of Botany 45, 31–37.

Ellis, R.H., Hong, T.D., Roberts, E.H., 1986. Logarithmic relationship between moisture content and longevity in sesame seeds. Annals of Botany 57, 499–503.

Ellis, R.H., Hong, T.D., Roberts, E.H., 1988. A low moisture content limit to logarithmic relations between seed moisture content and longevity. Annals of Botany 61, 405–408.

Harrington, J.F., 1970. Seed and pollen storage for conservation of PGR. In: Frankel, O.H., Bennet, E. (Eds.), Genetic Resources in Plants; Their Exploitation and Conservation. Blackwell, Oxford, pp. 501–512.

Harrington, J.F., 1972. Seed storage and longevity. In: Koslowski, T.T. (Ed.), Seed Biology, vol. 3. Academic Press, New York, pp. 145–245.

Hay, F.R., Probert, R.J., 1995. Seed maturity and the effect of different drying conditions on desiccation tolerance and seed longevity in foxglove (*Digitalis purpurea* L.). Annals of Botany 76, 427–639.

Obunyali, C.O., 2007. A study on the effects of various dormancy breaking treatments on germination of wild sesame species' (*Sesamum latifolium* Gillet, *S. angolense* Welw., and *S. angustifolium* Engl.) seeds and their longevity. MPhil. Thesis. Moi University, Kenya.

Probert, R.J., Hay, F.R., 2000. Keeping seeds alive. In: Black, M., Bewley, J.D. (Eds.), Seed Technology and Its Biological Basis. Sheffield Academic Press, Sheffield, UK, pp. 375–410.

Roberts, E.H., 1973. Predicting the storage life of seeds. Seed Science and Technology 1, 499–514.

Roberts, E.H., 1991. Genetic conservation in seed banks. Biological Journal of Linnaean Society 43, 23–29.

Roberts, E.H., Ellis, R.H., 1982. Physiological, ultra structural and metabolic aspects of seed viability. In: Khan, A.A. (Ed.), The Physiology and Biochemistry of Seed Development, Dormancy and Germination. Elsevier Biomedical Press, Amsterdam, pp. 465–485.

Smith, R.D., 1992. Seed storage, temperature and relative humidity. Seed Science Research 2, 113–116.

Steiner, A.M., Ruckenbauer, P., 1995. Germination of 110-year-old cereal and weed seeds, the Vienna Sample of 1877; verification of effective ultra-dry storage at ambient temperature. Seed Science Research 5, 195–199.

Walters, C., Wheeler, M.L., Grotenhuis, J.M., 2005. Longevity of seeds in genebank: species characteristics. Seed Science Research 15, 1–20.

Wass, P., 1995. Kenya indigenous forests. Status, Management and Conservation. IUCN, Gland, pp. 1–48.

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